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EXAMINER	
RUGGLES, JOHN S	
ART UNIT	**PAPER NUMBER**
1756	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	01/19/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No.	Applicant(s)	
	10/689,547	CROCKER ET AL.	
	Examiner	Art Unit	
	John Ruggles	1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08 December 2006 and 08 November 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-13,16-47,49,50,66-78 and 83-101* is/are pending in the application.

4a) Of the above claim(s) *4,5,74-78 and 83-97* is/are withdrawn from consideration.

5)☐ Claim(s) *none* is/are allowed.

6)☒ Claim(s) *1-3,6-13,16-47,49,50,66-73 and 98-101* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *08 November 2006* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

In the current 11/8/06 amendment and in the current supplemental 12/8/06 amendment, the status of the claims as indicated in the claims listing on pages 4-12 of 22 of the 11/8/06 amendment is as follows:

claims 1, 37-40, 47, and 66 are *currently amended*,

claims 2-3, 6-13, 16-36, 41-46, 49-50, and 67-73 remain as *original*,

claims 4-5, 74-78, and 83-97 remain *withdrawn* as previously non-elected,

claims 14-15, 48, 51-65, and 79-82 are now **canceled**, and

new claims 98-101 are currently added for the first time.

Therefore, only claims 1-3, 6-13, 16-47, 49-50, 66-73, and 98-101 remain under consideration as currently amended and as further limited by the previously elected specie (2) drawn to only methods of repairing or making phase shift masks (PSMs) for radiation lithography.

Claim 14 is non-compliant, because the text for this claim is presented along with the "canceled" status identifier.

This application still contains withdrawn (non-elected) claims 4-5, 74-78, and 83-97, so a complete reply to this final rejection must include cancellation of all non-elected claims or other appropriate action, as indicated below.

The previous objections to the drawings numbered (i)-(iv) are withdrawn in view of the current 11/8/06 replacement sheets for Figures 1 and 3B. However, the previous drawings objections numbered (v), (vi), (vii), and (viii) have not been sufficiently addressed and therefore these latter drawings objections are maintained below.

The previous specifically exemplified objections to the abstract numbered (1)-(4) and the previous exemplified objections to the specification numbered (1)-(3) are withdrawn in view of current specification amendments. However, further examples of objections to the specification are listed below.

The previous objection to claims 81-82 is withdrawn, because these claims are now canceled.

The previous rejection of claims 37-39 under the second paragraph of 35 U.S.C. 112 is withdrawn in view of the current amendment. However, the current amendment has also necessitated a new rejection under the second paragraph of 35 U.S.C. 112, which is set forth below.

The previous prior art rejections under 35 U.S.C. 102(b) are withdrawn in view of the current amendment. However, the current amendment has also necessitated a new ground of rejection over a previously cited prior art reference, which is set forth below. The previous prior art rejections under 35 U.S.C. 103(a) are re-written below as necessitated by Applicants' current amendment. Accordingly, the rejections set forth below are now made FINAL.

Election/Restrictions

This application still contains withdrawn claims 4-5, 74-78, and 83-97, which are drawn to invention(s) previously non-elected with traverse in the election response filed on 2/27/06. A complete reply to this final rejection must include cancellation of all non-elected claims or other appropriate action (37 CFR 1.144). See MPEP § 821.01.

Drawings

The previous objections to the drawings numbered (i)-(iv) are withdrawn in view of the current 11/8/06 replacement sheets for Figures 1 and 3B. However, the previous drawings objections numbered (v), (vi), (vii), and (viii) have not been sufficiently addressed and therefore these latter drawings objections are maintained below.

The drawings are still objected to at least because: (v) "Figure 3" is mentioned in the specification at page 15 line 24 but this figure number is still not found in the actual drawings; (vi) the 11/8/06 replacement sheet for Figure 19 is improved over the original version, but this drawing still is not clear enough to readily distinguish the lines described as having been formed in the feature; (vii) the 11/8/06 replacement sheet for Figure 21 is improved over the original version, but this drawing still is not clear enough to readily distinguish the detail and/or edge locations for the described initial additive repair; and (viii) Applicants are further expected to correct any other errors not specifically listed above in either the drawings or their corresponding descriptions in the specification.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the

renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Specification

The previous specifically exemplified objections to the abstract numbered (1)-(4) and the previous exemplified objections to the specification numbered (1)-(3) are withdrawn in view of current specification amendments. However, further examples of objections to the specification are listed below.

35 U.S.C. 112, first paragraph, requires the specification to be written in "full, clear, concise, and exact terms." The specification is replete with terms, which are not clear, concise and exact. The specification should be revised carefully in order to comply with 35 U.S.C. 112, first paragraph. Examples of some unclear, inexact or verbose terms used in the specification are: (4) on page 2 in the 5th full paragraph (a) at line 6, "pinholes" should be changed to --, e.g., pinholes-- and (b) at line 8, "defect" (singular) should be corrected to --defects-- (plural); (5) on page 3 at line 22, "to pattern" should be changed to --[[to]] for patterning--; and (6) on page 5 in the 4th paragraph (a) at line 1, "Attenuating PSM (weak shifters) relies on" should be corrected to --Attenuating PSMs (having weak shifters) ~~relies~~ rely on-- and (b) at line 4, "photomask" (singular) should be corrected to --photomasks-- (plural). Note that due to the number of errors, those listed here are merely *examples* of the corrections needed and do *not* represent an exhaustive list thereof.

Appropriate correction is required. An amendment filed making all appropriate corrections must be accompanied by a statement that the amendment contains no new matter and also by a brief description specifically pointing out which portion of the original specification provides support for each of these corrections.

Claim Objections

The previous objection to claims 81-82 is withdrawn, because these claims are now canceled.

Claim Rejections - 35 USC § 112

The previous rejection of claims 37-39 under the second paragraph of 35 U.S.C. 112 is withdrawn in view of the current amendment. However, the current amendment has also necessitated a new rejection under the second paragraph of 35 U.S.C. 112, which is set forth below.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 6 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention.

In claim 6, it is unclear how the additive repair of claim 1 as currently amended (from which claim 7 depends) would be expected to remove an opaque defect (e.g., of excess chrome (Cr) on a patterned mask having a transparent substrate, etc.). However, for the purpose of this Office action, the opaque defect in claim 6 is interpreted to be in addition to a missing part or

deficiency defect that is additively repaired with appropriate coating material from the atomic force microscope (AFM) tip in claim 1 (as currently amended).

Claim Rejections - 35 USC § 102/103

The previous prior art rejections under 35 U.S.C. 102(b) are withdrawn in view of the current amendment. However, the current amendment has also necessitated a new ground of rejection over a previously cited prior art reference, which is set forth below. The previous prior art rejections under 35 U.S.C. 103(a) are re-written below as necessitated by Applicants' current amendment.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-2, 6-13, 16, 18, 20-23, 26, 30-31, 34, 36-42, 44, 46-47, 49-50, and 98-100 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999).

Lewis et al. teach a process of repairing a mask by delivering liquid or gas through a cantilevered hollow micropipette attached to an atomic force microscope (AFM) tip or probe

head, allowing nanometric spatial control of specifically localized chrome etching to be demonstrated without detectable effects on the underlying glass substrate of the mask (abstract, *instant claims 2, 6, 16, 36-39, 41-42, 46, 49*). For the micropipette, a quartz nanopipette can have an outer diameter at the tip of 10nm and a hole in the middle that can be as small as 3nm (p2689/left col., which is clearly capable of repairing defects that are of similar or larger size, reading on *instant claims 9, 10-12, 13*). A reflective metal layer on the backside is used to detect bending movement of the AFM cantilever (Figure 1, p2689/right col.). The width of etched lines includes specific examples at 100nm and 1,150nm, with the depth exemplified by 120nm and 200nm, respectively (p2691/left col., *instant claims 20-23*). Contemplated variations specifically include the use of intermittent contact-mode AFM delivery similar to that achieved by an ink jet printer, controlled distribution or confinement of liquid between the pipette or hollow tip and the substrate treated by altering the geometry or the surface of the hollow pipette tip to be either hydrophobic or hydrophilic, or alternative equipping of the pipette or hollow tip of an AFM to apply an electrical voltage or illumination on the surface treated to further improve resolution of the pattern formed or repaired (e.g., on the mask, etc.). This technology has wide implications both for the use of this methodology in controlled nanochemistry with liquids or reactive gases (p2691/right col.). For the purpose of this rejection, the contact-mode AFM delivery similar to that achieved by an ink jet printer (which is very well known for selectively depositing ink as coating material) is interpreted as being inherently capable of additive patterning by using a coated AFM tip to deliver coating material for selectively making or repairing a patterned mask. Also in this rejection, the controlled distribution or confinement of liquid between the hollow tip and the substrate treated by altering the geometry or the surface of the hollow tip to be either

hydrophobic or hydrophilic is understood to facilitate transfer of liquid such as coating material from the tip to the surface treated (e.g., to repair a nanometer scale missing part or clear defect on a patterned mask by depositing an opaque material such as Cr [noting that it is well known in the metal coating art that a metal coating can be derived from post-treatment of a deposited precursor material or compound containing such metal], etc., *instant claims 7-8, 18, 26, 30, 34, 44, 50*). This further suggests the inherent suitability of an AFM having a tip coated with material for delivery to a desired substrate to effect additive repair of a patterned mask and/or a desired etchant for subtractive repair of a patterned mask, without requiring any voltage bias between the AFM tip and the desired substrate or the mask, and also without requiring any vacuum conditions during such treatment of the desired substrate or the mask (*instant claims 1, 31, 40, 47, 98-100*).

Claims 1-3, 6-13, 16, 18-23, 26, 29-42, 44-47, 49-50, 66-72, and 98-101 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999) in view of Miller (US 6,270,946).

The teachings of Lewis et al. discussed above that include the finely controlled selective delivery of liquid material from an AFM having a hollow tip coated with the liquid material onto a defective patterned mask for repair of defects on the mask is interpreted in this rejection to primarily focus on subtractive repair of defective patterned masks by etching to remove excess defects (e.g., to remove excess opaque Cr defects from a patterned mask, etc.). Even though alternatively contemplating the potential suitability of using an AFM tip to alternatively selectively deposit material for additive repair of a defective patterned mask (as discussed

above), Lewis et al. do not teach specific examples or any detailed description of such additive repair for patterned masks.

Miller teaches a process of patterning and/or building up layered nanoscale features on a substrate by selectively applying first and second materials with a nanoscale delivery device. A first difunctional molecule is applied and reacted with a surface of the substrate and a second difunctional molecule is applied and reacted with previously unreacted functional groups from the first difunctional molecule to form a patterned layer on the surface of the substrate (title, abstract). The difunctional molecule may be any that is known to those skilled in the art, such as a difunctional monomer, oligomer, or polymer. The number or repeating units in the backbone of the molecule can range from one to thousands (1 to 1,000s, which clearly reads on high molecular weight compounds), depending on the final application and intended use (c2/L39-48). Any known substrate material can be used; particularly materials such as glass, metal (Au), silicon (Si), polymers, or germanium (Ge) are given as examples of suitable substrate materials (c2/L59-67). Any device known to those skilled in the art may serve as the nanoscale delivery device. Figure 2 shows the device 40, in general, comprising a probe 50 having a microfluidic device 60 attached thereto. One type of probe used is a proximal probe from an atomic force microscope (AFM). The microfluidic device forces or encourages the flow of the molecule to be applied to the surface of a substrate or another molecule. The probe may be chemically treated to induce transfer. Alternatively or in addition to the chemical treatment, a carbon nanotube may be incorporated into the probe tip. These nanotubes function similarly to that of a (hollow) fountain pen, making it possible to transfer the difunctional molecule to the substrate or to direct placement of the difunctional molecule with respect to a previously reacted difunctional

molecule. The nanoscale delivery device allows formation of an ultra small pattern for further processing into such devices as semiconductors or electronic devices in a cost effective, well controlled manner (c3/L31-53). Reaction of the first and second difunctional molecules at functional groups can be enhanced by exposure to a radiation source, such as a scanning electron beam, x-rays, ultraviolet (UV) or visible light, or a thermal energy source (c2/L54-65). The radiation energy source can be extended from a nanoscale delivery device, as previously described (c3/L33-34). AFM probes have been previously known to transfer a very small amount of chemical material onto a surface to form a very small feature (tens of nm in dimension, c1/L36-40). As exemplified in step 6 of Figure 1, many multiple layers of either the same or different materials can be built up on a common substrate to form nanoscale features of the desired coating materials and total thickness, which are determined by the final application for the multilayered product (c4/L56 to c5/L9).

It would have been obvious to one of ordinary skill in the art at the time of the invention in the subtractive patterned mask repair process using an AFM having a hollow liquid coated tip with extremely fine control over the removal of excess opaque material defects (as taught by Lewis et al.) to alternatively or even additionally extend the use of the extremely finely controlled AFM tip for additive repair of the patterned mask by distributing desired coating material from the AFM tip (that may be chemically treated to induce transfer) onto a substrate of any suitable known material (e.g., glass, metal, etc.), including building up plural layers of this coating material (as taught by Miller). This is because at least the glass and metal substrate materials considered suitable for coating and even building up plural layers of coating material (taught by Miller) would be compatible with patterning or repairing a finely patterned mask

having a metal pattern on a glass substrate (as taught by Lewis et al.), which provides a reasonable expectation of success for additive repair of a clear deficiency defect in an opaque pattern on a finely patterned mask by using the finely controlled AFM having a liquid coated tip. This AFM having a liquid coated tip would also function as a nanoscale delivery device to allow formation of an ultra small patterned feature (tens of nm in dimension) in a cost effective, well controlled manner (as taught by Miller). Furthermore, this AFM having a liquid coated tip would also be suitable for extremely finely controlled selective coating and/or selective etching of electrically non-conductive substrates as well as conductive substrates, including multilayer structures of diverse materials (e.g., to repair a defective mask such as a PSM having a conductive metal pattern on a non-conductive substrate, etc.), because an AFM probe tip can be used with conductive and/or non-conductive substrates (*instant claims 1-3, 6-13, 16, 18-23, 26, 29-42, 44-47, 49-50, 66-72, and 98-101*).

Claims 1-3, 6-13, 16-23, 25-27, 29-42, 44-47, 49-50, 66-73, and 98-101 are rejected under 35 U.S.C. 103(a) as being unpatentable over either Cohen (US 5,865,978), Yedur et al. (US 6,197,455), or Bard et al. (US 4,968,390) in view of either Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999) or Miller (US 6,270,946).

Cohen teaches nanoscale production or modification of near field masks (title), including repairing or fixing mask defects (c12/L33-46), by using an STM (scanning tunneling microscope, which is among the many types of scanning probe microscopes (SPMs) that include atomic force microscopes (AFMs), c2/L34-41, both of which have been known for manipulating individual atoms to additively create nanoscale structures, c3/L9-19) as an "electrochemical

paintbrush" for transfer coating of copper (Cu) from a massive Cu supply onto the STM electrode so that the coating material coats the STM tip (shown in Figure 6A as platinum (Pt) 131 with a paraffin insulator film 132, leaving only the Pt tip uncovered by the insulator film to allow addition of the coating material 701, c9/L60 to c10/L31), then depositing the coating material 701 from the STM tip to an ITO surface without degrading the STM tip (abstract, c11/L24-25,38-41). An STM deposits a pattern of Cu or other suitable opaque material that is electroplateable (e.g., gold (Au), silver (Ag), tin (Sn), zinc (Zn), nickel (Ni), chromium (Cr), etc.) onto a transparent ITO electrode, which is then used as a photolithographic mask. With reference to Figure 9B, a near field mask 800 is directly placed against a photosensitive substrate (e.g., a semiconductor chip 804 or wafer, etc.) coated with a light sensitive resist 802, and exposed to a light source. Preferably, the opaque mask pattern is placed in touching contact with the resist coating. This STM method has high resolution at the nanoscale for making or repairing masks having high resolution patterns for sub-wavelength exposure of a resist (e.g., nanolithography, etc.), while retaining the speed and production volume of conventional photolithography (c15/L17-61). As an example, Figures 8A and 8B show STM scans before and after Cu deposition, to fill in between the ridges shown in Figure 8A. In this example, the area filled in with metal varies from about 5nm to 10nm wide at the base to about 20nm to 30nm wide at the top, about 130nm long, and over 50nm high (c13/L34-47). However, it is specifically disclosed to be important that this method is not confined to use in the nanoscale range and can alternatively be used to deposit, mill, or remove material in larger dimensional amounts, for depositing other electrochemically active material besides opaque metal (such as optically transparent material, e.g., indium tin oxide (ITO), *instant claims 17, 25, and 73*) that has

desirable optical properties, or for other uses in either inorganic or organic chemistry (c13/L52-65, c14/L4-28).

Yedur et al. teach a method of repairing a lithographic photomask or mask (specifically contemplated to overcome previous drawbacks of ion beam or laser beam repair techniques for masks that typically yield either unacceptable results or introduce undesirable phase or transmission defects in the final mask, c2/L16-24, such as a phase shifting mask, PSM) intended for the semiconductor industry (c1/L5-19) by involving use of a scanning tunneling microscope (STM) to either remove material from excess defects or deposit material in voids or deficiency defects (abstract). STM imaging or patterning of a resist improves accuracy of the mask repair, allowing defects having a size of only 10 Å (1 nm, 0.001 microns) or greater to be corrected (c2/L59-62, emphasis added), which for square shaped defects would be equivalent to each single defect on the mask or PSM having an area = 0.000001 square microns or greater. Deposition to repair defects includes STM tip induced reaction with surrounding gases to deposit suitable material (c6/L52-67), such as carbon (C), chrome (Cr), amorphous silicon (Si), or other compatible material, including that resulting from the reaction of C atoms in the surrounding gases with a tungsten (W) STM tip (c7/L1-16, reading on chemical vapor deposition (CVD) to repair a defect on a mask, such as a PSM, *instant claims 3 and 27*). This method is not limited to only the materials listed above, but may be used to repair any number of mask materials (c7/L34-37, instant claims 33-34, 55).

Bard et al. teach high resolution deposition and etching in polymer films (title) utilizing a scanning electrochemical microscope (SECM) as a modified version of an STM for etching and electrochemically depositing various conducting substances on the surface of a conductive object

that includes placing the SECM tip in contact with the conductive object (abstract). This allows deposition of extremely fine patterns of metals, semiconductors, or polymers in polymer films and etching of a conducting substrate with very high resolution (c1/L15-20). Figures 2(a)-(d), 4(a)-(b), and 5-6 show copper (Cu) lines about 1,000nm in width, silver (Ag) lines ≤ about 500nm in width, Cu deposits < about 500nm in diameter, and an etched Cu line < about 1,000nm in width (c4-7). Applications include deposition of semiconductors or electrically conductive polymers, controlled polymerization or crosslinking of a polymer film, deposition of several metals and/or polymers in the same film, insulator or metal oxide deposition (e.g., Al_2O_3, SnO_2, Fe_2O_3, etc.), and deposition of structures composed of two or more different materials (c6/L61-c7/L21). A specifically described embodiment includes repairing or producing of masks with high resolution features (e.g., for x-ray or electron beam lithography, etc.) by deposition (of e.g., Au, etc.) lines that are typically on the order of 500nm-1,000nm in depth or thickness (c2/L56-59, c6/L53-55, c7/L22-31). This technique provides constant tip/substrate electrode distance for uniform films and results in more uniform structures (c3/L15-18). Figure 3 shows an example for using this method to produce or repair a mask pattern having a conductive pattern (of e.g., gold (Au), chromium (Cr), etc.) by deposition on a transparent substrate using a high resolution SECM or STM tip (c7/L53-c8/L5 and c11/L4-8, *instant claim 73*).

While teaching the use of a SPM probe tip, such as a STM probe tip or a SECM probe tip, having coating material either directly on the probe tip or deposited from the surrounding environment at the probe tip, for additive patterning processes to produce or repair a patterned mask (e.g., a PSM, etc.), none of Cohen, Yedur et al., nor Bard et al. specifically teach the use of an AFM tip or a hollow tip for such patterning processes.

The teachings of Lewis et al. and Miller are discussed above.

It would have been obvious to one of ordinary skill in the art at the time of the invention in the patterning processes to produce or repair a mask (e.g., a PSM, etc.) with extremely fine control over coating and/or etching steps by using a SPM probe tip, such as a STM probe tip or a SECM probe tip (taught by either Cohen, Yedur et al., or Bard et al.), to use an alternative and/or an additional SPM probe tip, such as a hollow tip AFM probe (as taught by either Lewis et al. or Miller), in order to extend the substrate materials treated by extremely finely controlled coating and/or etching to electrically non-conductive substrates as well as conductive substrates, including multilayer structures of diverse materials (e.g., to repair a mask such as a PSM having a conductive metal pattern on a non-conductive substrate, etc.), because an AFM probe tip does not require application of a voltage bias between the AFM tip and the substrate being treated. Therefore, the use of an AFM probe tip coated with a desired coating material would provide a reasonable expectation of success for extremely finely controlled selective coating of a non-conductive substrate (e.g., for additive repair of a missing part or a deficiency defect in an opaque metal pattern on a transparent substrate of a patterned mask such as a PSM, etc., *instant claims 1-3, 6-13, 16-23, 25-27, 29-42, 44-47, 49-50, 66-73, and 98-101*).

Claims 24, 43, and 50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999) in view of Park et al. (US 5,871,869).

While teaching other aspects of the instant claims, Lewis et al. do not specifically teach using a sol-gel coating material (*instant claims 24, 43, 50*) for additive patterning or repairing of a mask, such as a PSM.

Park et al. teach a method of manufacturing a PSM that includes patterning a PS layer (title, abstract). This PSM is usable for forming fine patterns in a semiconductor device (c1/L5-11). Figure 2 shows an example of a PSM having a PS layer of a metal oxide (e.g., TiO_2, ZrO_2, CrO_2, ZnO_2, etc.) coated by a sol-gel method to yield a refractive index of about 1.6 to 2.3 on a transparent substrate (e.g., of soda lime glass, quartz, etc.). The thickness of the PS layer (e.g., about 140nm to 310nm, etc.) formed from the sol-gel is determined from equation 1 based on the incident exposure wavelength (e.g., 365nm, etc.) and the refractive index of the PS layer, in order to shift the phase of the incident light by 180° (c3/L15-39, c4/L6-8).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention in the additive patterning processes to produce or repair a mask (e.g., a PSM, etc.) with extremely fine control over coating and/or etching steps by using a SPM probe tip, such as a hollow tip AFM probe (taught by Lewis et al.) that includes depositing a desired thickness of transparent PS sol-gel coating material on the PSM (as taught by Park et al.), because this would provide a reasonable expectation of success for producing or repairing transparent PS material on a PSM by extremely finely controlled addition of sol-gel coating material on either electrically conductive or non-conductive substrates, including multilayer structures of diverse materials (e.g., to repair a mask such as a PSM having a conductive metal pattern on a non-conductive substrate, etc., *instant claims 24, 43, and 50*).

Claims 24, 43, 50, and 73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999) in view of Miller (US 6,270,946) and Park et al. (US 5,871,869).

While teaching other aspects of the instant claims, Lewis et al. and Miller do not specifically teach using a sol-gel coating material (*instant claims 24, 43, 50, and 73*) for additive patterning or repairing of a mask, such as a PSM.

The teachings of Park et al. are discussed above.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention in the additive patterning processes to produce or repair a mask (e.g., a PSM, etc.) with extremely fine control over coating and/or etching steps by using a SPM probe tip, such as a hollow tip AFM probe (taught by Lewis et al. and Miller) that includes depositing a desired thickness of transparent PS sol-gel coating material on the PSM (as taught by Park et al.), because this would provide a reasonable expectation of success for producing or repairing transparent PS material on a PSM by extremely finely controlled addition of sol-gel coating material on either electrically conductive or non-conductive substrates, including multilayer structures of diverse materials (e.g., to repair a mask such as a PSM having a conductive metal pattern on a non-conductive substrate, etc., *instant claims 24, 43, 50, and 73*).

Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999) in view of Hattori et al. (US 2002/0086223).

While teaching other aspects of the instant claim for additive patterning processes to produce or repair a mask with extremely fine control over coating and/or etching steps by using an AFM having a hollow tip, Lewis et al. do not specifically teach the deposition of a material including nanoparticles (*instant claim 28*) for additive patterning or repairing of a mask, such as a PSM.

However, Hattori et al. teach that it has been known to pattern a PS material on a PSM by either coating a transparent film (e.g., glass, etc.) on a mask substrate or just starting with such a transparent material (e.g., glass, etc.) substrate for a mask, etching through a patterned resist to form a PS pattern, then coating a film containing nanoparticles (e.g., in a binder, etc.), and patterning the film containing nanoparticles to form a shade pattern on the PSM ([0048]-[0049], as an opaque or a light blocking pattern on the PSM).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention in the additive patterning processes to produce or repair a mask (e.g., a PSM, etc.) with extremely fine control over coating and/or etching steps by using an AFM having a hollow tip (as taught by Lewis et al.) to deposit an alternative opaque coating material that includes nanoparticles, because it has been known in the mask art to form an alternative shade or opaque pattern made from a coating material that includes nanoparticles on a PSM (as taught by Hattori et al.). Thus, the use of a known alternative opaque coating material containing nanoparticles would provide a reasonable expectation of success in the additive repair of an opaque material pattern on a mask such as a PSM, in order to achieve the known benefits of the coating material containing nanoparticles (*instant claim 28*).

Claim 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al. (Fountain Pen Nanochemistry: Atomic Force Control of Chrome Etching, Applied Physics Letters, Vol. 75, No. 17, 1999) in view of Miller (US 6,270,946) and Hattori et al. (US 2002/0086223).

While teaching other aspects of the instant claim for additive patterning processes to produce or repair a mask with extremely fine control over coating and/or etching steps by using

an AFM having a hollow tip, Lewis et al. and Miller do not specifically teach the deposition of a material including nanoparticles (*instant claim 28*) for additive patterning or repairing of a mask, such as a PSM.

The teachings of Hattori et al. are discussed above.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention in the additive patterning processes to produce or repair a mask (e.g., a PSM, etc.) with extremely fine control over coating and/or etching steps by using an AFM having a hollow tip (as taught by Lewis et al. and Miller) to deposit an alternative opaque coating material that includes nanoparticles, because it has been known in the mask art to form an alternative shade or opaque pattern made from a coating material that includes nanoparticles on a PSM (as taught by Hattori et al.). Thus, the use of a known alternative opaque coating material containing nanoparticles would provide a reasonable expectation of success in the additive repair of an opaque material pattern on a mask such as a PSM, in order to achieve the known benefits of the coating material containing nanoparticles (*instant claim 28*).

Response to Arguments

In response to Applicants' assertion in the current 11/8/06 amendment on pages 16-17 that the examiner has combined an excessive number of references, reliance on a large number of references in a rejection does not, without more, weigh against the obviousness of the claimed invention. See *In re Gorman*, 933 F.2d 982, 18 USPQ2d 1885 (Fed. Cir. 1991). Nevertheless, the obviousness rejections have all been re-written as necessitated by the current amendment. In the re-written obviousness rejection citing the largest number of prior art references, the three primary references are only cited alternatively and the two secondary references are only cited

alternatively, contrary to Applicants' assertion that an excessive number of references have been used.

In response to Applicants' arguments on pages 17 and 19 that the examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the Applicants' disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971). Furthermore, since the STMs, SECMs, and AFMs taught by the cited prior art references are all included within the broader category of SPMs (in particular, see the teachings of Cohen and the other references as discussed above) and the reasons for combining the references cited are explained above, the examiner does not believe that any improper hindsight was relied upon, especially since the knowledge necessary for combining the cited references was within the level of ordinary skill in the SPM art and the mask repair art (both of which were clearly in the same field as Applicants' endeavor at the time of the instant invention).

In response to Applicants' arguments on pages 17-18 that the differences between the instant claims and the previously cited prior art are too large and represent an alleged difference in kind, as well as the differences between the primary references using STM or SECM tips and the secondary references using AFM hollow tips, generally arguing against the use of nonanalogous art; it has been held that a prior art reference must either be in the field of Applicants' endeavor or, if not, then be reasonably pertinent to the particular problem with which

the applicant was concerned, in order to be relied upon as a basis for rejection of the claimed invention. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). In this case, the prior art references are both in the field of Applicants' endeavor and are also reasonably pertinent to the particular problem with which the Applicant was concerned (also, see the above response to Applicants' hindsight arguments on pages 17 and 19).

In response to Applicants' argument on page 18 that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, the particular reasons for combining the references in the re-written rejections set forth above are presented in the corresponding rejections.

In response to Applicants' argument on page 18 that the application of material from the coated AFM tips taught by either Lewis et al. or Miller are incompatible with the application of material from the STM and SECM tips taught by Cohen, Yedur et al., or Bard et al., the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981). In this case, these prior art references are all in the same field of Applicants' endeavor for applying material from a SPM type probe tip (albeit from

an STM tip, an SECM tip, or an AFM tip). Although it is recognized that the transfer of coating material from STM tips or SECM tips onto an electrically conductive substrate differ in particular operation from the transfer of coating material from AFM tips, this difference provides motivation for using an AFM tip instead of an STM tip or an SECM tip (see the above discussion of the applicable primary and secondary references as well as a further explanation of the basis for this motivation).

In response to Applicants' arguments on pages 18-19 against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Only Lewis et al. is relied upon alone, based on a particular first interpretation of the teachings in this reference, while all the other prior art rejections are based on various combinations of references (including Lewis et al. based on a particular second interpretation of the teachings in this reference) as set forth above.

Applicants' other arguments with respect to the instant claims have been considered, but they are either unpersuasive or moot in view of the new and re-written ground(s) of rejection set forth above, as necessitated by Applicants' current amendment.

Conclusion

Applicants' amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicants are reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 571-272-1390. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 571-272-1385. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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